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Electric Medicamental Diffusion.

METALLIC ELECTROLYSIS—CATAPHORESIS—SOLUBLE METALLIC ELECTRODES WITH ILLUSTRATIVE CASES OF TINNITUS, AURIUM, TRACHOMA, NASAL AND POST-NASAL CATARRH, URETHRITIS, TONSILLITIS, VASCULAR TUMOR, DERMOID CYST, NÆVI, SYCOSIS, ETC.

Read at the Fourth Annual Meeting of the American Electro-Therapeutic Association, held at New York, Sept. 25, 26 and 27, 1894.

BY WILLIAM JAMES MORTON, M.D.

Professor Diseases of the Mind and Nervous System and Electro-Therapeutics, New York Post-Graduate Medical School and Hospital; Member New York Academy of Medicine of the American Neurological Association; Société Francaise D'Électro-Thérapie, Etc., Etc.



REPRINTED FROM
THE JOURNAL OF THE AMERICAN MEDICAL ASSOCIATION
MAY 4, 1895.

presented by the author -

CHICAGO:
AMERICAN MEDICAL ASSOCIATION PRESS.
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ELECTRIC MEDICAMENTAL DIFFUSION.

It often happens in medicine that a new method of procedure makes its way to success by a series of steps not seemingly related to each other in time or relevancy. This observation seems to me to be true of a number of individual therapeutic procedures which during recent years have been brought to the attention, particularly, of those interested in applying electricity to the cure of disease. Reaching back to the time of Fabré-Palaprat in 1833 (introduction of iodid of potassium through the skin), including the success of Benjamin Richardson in 1859 (voltaic narcotism) and culminating in recent years in the practical applications of Peterson, the writer and others (electro-cocain anesthesia, etc.), the term cataphoresis has sufficed both to name and to explain the practical facts. By aid of this principle of cataphoresis, fluids of the human tissue may be moved about, particularly in parts free from active blood circulation, from the positive to the negative pole, or medicine held in solution at a positive pole may be caused to penetrate the skin or mucous membrane at the site of that pole. The practice is equally available whether the polar electrode be the usual small one, or be a large one, as in the case of the water of an electric bath. And not only may medicines be thus introduced (as demonstrated by an examination of the urine) but they may also be removed from the human system (as demonstrated by using a bright copper plate electrode for the negative pole in the bath and finding a removed metallic deposited upon the copper). So far as relates to the introduction or the removal of medicinal substances, I have termed the process cataphoric medication and cataphoric demedication. I have also established a method useful in gouty and rheumatic joints and in other conditions of cutting off the blood supply by rubber rings or by an Esmarchs'

bandage and thus affording the medicine introduced greater facility to act upon the affected tissue. This process I have termed anemic cataphoric medication. Turning to another set of the isolated phenomena, which I am about to suggest may be included under one general caption and nomenclature, we are confronted with that great and fundamental principle of electrolysis without which there would be no conduction of electricity in the human tissue, and yet so diverse are its exhibitions according to the strength of the current, according to the actual decomposition of the tissue or its non-evident decomposition, and according to the fluids in solution at the poles of the applied electrode or the nature of the electrode itself when introduced within the tissue, that confusion reigns as to specific effects and methods.

Involved in this principle of electrolysis and the introduction of medicinal substances into tissue, there are a great variety of special processes as, for instance, cataphoric medication already alluded to, and furthermore, processes where the electrode itself furnishes by electrolysis of its own substance the new medicine introduced (soluble electrodes) or where an insoluble electrode conveys the current which decomposes a fluid introduced within the cavity to be treated. The two latter methods are known as the "interstitial electrolysis" of Gautier, or in the case of the soluble electrode as "metallic interstitial electrolysis" of the same author. The simple fact which arises out of this confusion is that the electric current causes a diffusion of the medicines into and throughout the tissue.

It matters not whether the medicine in solution be applied by a sponge or blotting paper against the skin (cataphoric medication), be held in solution in the water of an electric bath (again cataphoric medication), be injected into a cavity and decomposed (interstitial electrolysis), be dissolved by the action of a current off of a needle perforating the tissue (metallic electrolysis), or be dissolved from an electrode held in contact with mucous membrane (also metallic electrolysis); the result is the same—a foreign substance in solution, viz., a medicine is caused to enter and permeate the tissue. It therefore seems to me to be a

proper time to generalize the entire facts under the term of electric diffusion of medicines into human tissue or, simply, *electric medicamental diffusion*.

To secure this diffusion it is only necessary that the artificial and applied electrolyte (the medicine or substance in solution) be caused to constitute a part of the electrolyte into which it is to be diffused and then the general principles of both electrolysis and cataphoresis come into play; the various ions are redistributed or diffused according to well-known laws, while also, equally, the principle of cataphoresis is at work whereby irrespective of ionic distribution, fluids are moved from the positive to the negative pole or sometimes *vice versa*. This diffusive property of the current, taken advantage of in connection with human tissue, opens out to electro-therapy and general medicine an immense and a fascinating field of study and practice, and in many important directions points out entirely new treatments of a great variety of diseases thus far not commonly treated in this manner. The field is so broad a one that I will confine myself in this communication to the electric diffusion of metallic salts, one form of the interstitial electrolysis of Gautier.

ELECTRIC DIFFUSION FROM SOLUBLE ELECTRODES.

The destructive electrolytic action in human tissue of either pole of a continuous electric current is perfectly familiar. The electrodes are usually of metal, and care is taken that they be unoxidizable, as is, for instance, platinum or gold, if they are to be used at a positive pole, while, if used at the negative pole, they may be oxidizable or not. The positive pole electrode, when the current is in action, forms oxygen and acids out of the tissue itself; the acids are mainly hydrochloric, sulphuric and phosphoric. The negative pole forms hydrogen and alkalies, the latter usually caustic soda and potash. Each pole is practically a little chemic workshop by itself—the one acid, the other alkaline; the analytic and synthetic energy being furnished by the electric current and the materials acted upon being furnished by the tissue. The resultant and desired destruction of tissue is due to a number of factors, chief among which are that amount of tissue used

to make up the newly formed and foreign chemicals, the secondary action of these newly formed products upon the remaining tissue, and the disruptive effects upon the structural composition of the tissue of the gases interstitially liberated. And the character of the artificially produced lesion and its resultant eschar is determined, to a great extent, by the second of these actions, whether it has been an acid or an alkalin corrosion or destruction. The lesion resulting at the negative pole is rich in fluids (by cataphoresis), and is slower to heal; it leaves, however, a smoother and less contractile cicatrix (an important consideration in the removal of facial blemishes). The lesion resulting at the positive pole is comparatively dry (also by cataphoresis), is quicker to heal and leaves a rougher and more contractile scar.

It will be observed that in this, the familiar form of electrolysis, no account is taken of the nature of the active electrode employed except that it be unoxidizable, insoluble, and therefore indestructible, and that as a consequence reliance for the electrolytic effect is based directly upon the characteristic effect of the current upon the tissue and not upon its effect upon the electrode. Any action of the current upon the electrode is, in fact, carefully guarded against.

But if we turn our attention to the nature of the metal which composes the electrode, be it the positive or (as I have demonstrated) the negative, an entirely new field of investigation and of results is opened out to our view. If our positive electrode be composed of a metal which is attacked by oxygen or by chlorin (formed at that pole out of the tissue), then a new chemic compound is formed at the point of the application, and we have no longer to deal with the effect of the liberated chemicals directly upon the tissue, but we are confronted with a new effect, *viz.*, that of the newly formed chemic compounds (metallic salts) upon the tissue. And since, owing to the nature of human tissue, hydrochloric acid is pre-eminently formed at the positive pole, we shall find if copper, zinc, iron or other attackable metal is the metal employed at that pole, that we have formed respectively the oxychlorids of copper, zinc, iron, etc., double salts of the metal.

In this connection we may observe the further interesting

fact that under the above circumstances the action of the current is almost entirely expended in decomposing the metal, and that as a consequence the undesirable destructive action of the usual electrolysis is avoided. For, as I have observed in practice and as will be seen upon reference to the cases in which this method of treatment is applicable and peculiarly efficacious, the destructive action of the current would be in the highest degree detrimental. The object is not to destroy tissue, as by actual cautery or by the application of caustics, but to implant within it and permeate it with the newly formed metallic salt. In fact, so distinctive is this new method, which is termed by Gautier, its modern author, interstitial electrolysis, from common surgical electrolysis, that it is unfortunate to use the term, electrolysis, at all in relation to it. The electrolysis is, as has been pointed out, principally of the metal, and but to a very limited extent of the tissue. A far more characteristic feature of the process is that the product of the electrolized metal permeates tissue, and it is for that reason that I feel compelled, in speaking of the method, to designate it as electric diffusion.

Another noticeable feature of electric diffusion of salts formed from soluble electrodes is that a remarkably low current strength suffices to set free a large amount of the metallic salt. Here, again, is a reason that very little of the usual electrolytic destruction of tissue ensues. Gautier, indeed, calls attention to this fact, and characterizes this method in its gynecologic applications as one of low current strength and long sittings, in contra-distinction to the Apostoli method of high current strength and short sittings. In practical work, I have found that very low current strength, from 1 to 10 milliampères, gives much better results than from 10 to 50 milliampères. In this connection it should be noted that the electrode loses in weight. Gautier has found, as would be expected, that the loss in weight is proportional to the current strength and the duration of the current flow.

Again, the solution of the metallic electrode is not confined, as thus far supposed, to the positive electrode alone. I have found by experiment that soluble electrodes may also be employed at the negative pole. One of the best of the

metals for this purpose is aluminium. The extension of metallic electrolysis to the negative pole greatly widens the field of this new method, since, while at the positive pole we have thus far been confined to the oxychlorids of metals we now at the negative pole may apply to diseased tissue another class of metallic salts.

Electric diffusion, as the word, diffusion, indicates, possesses an obvious advantage over the ordinary topical applications of similar or other metallic salts of copper, zinc, iron, aluminium or other metals. For it is obvious that not only is the salt dissolved off of the metal, but by another and further property of the current it is forced into the tissue in a radiating direction around the metallic electrode. In this respect, electric diffusion is remarkably unlike the application of the ordinary solutions by a brush, spray or injection, or their injection into tissue by the hypodermatic needle. The solution of the salt is not only applied but it is driven in. To use a homely simile, a wash or spray is like a nail held against a board, while electric diffusion plays the part of the hammer which drives the nail home.

HISTORICAL—ELECTRODES—TECHNIQUE—CASES — CONCLUSIONS.

The dissolving action of the electric current upon a metallic electrode, constituting a positive pole and applied within human tissue, had been noted by various authors in relation to the treatment of some diseases, particularly tumors, by electrolysis. Both Butler and Stevenson and Jones refer to this action upon zinc needles and point out the conjoint efficacy of the combined destructive action of the current and the newly formed chlorid of zinc.

Onimus, of Paris, and Prochownick, of Hamburg, appear to have casually used soluble electrodes at the positive pole. The latter applied a copper sound with a current strength of from 80 to 100 milliampères in a case of gonorrhœal infection of the uterine cervical canal.

But these isolated observations made almost no impression upon practice, and it remained for Dr. Georges Gautier, of Paris, to grasp the broad idea of diffusing metallic salts from soluble electrodes and to inaugurate by a series of experiments this new system of procedure.¹

At once appreciating the far-reaching merits of the new method, I established its use in a great variety of cases in



FIG. 1.—“Soluble” Needles.

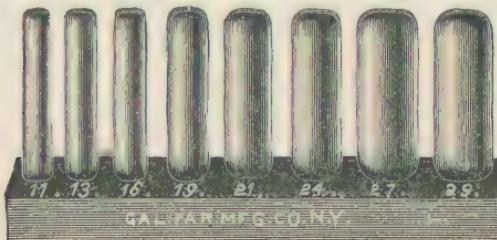


FIG. 2.—“Soluble” Bulbs.



FIG. 3.—“Soluble” Bulbs.

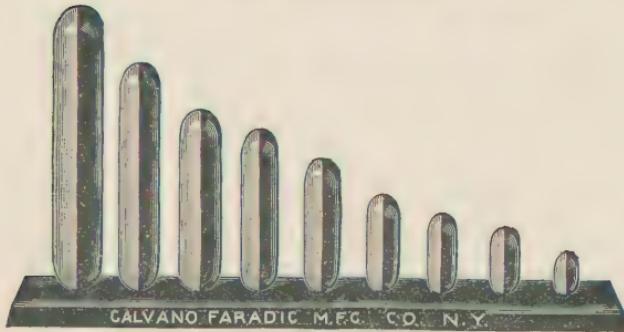


FIG. 4.—Protected Soluble Electrodes.

¹ Revue Internationale d’Electrothérapie, July, 1891, August and September, 1892. Also Technique d’Electrothérapie, by Drs. Gautier and Larat.

my clinic at the New York Post-Graduate Medical School and Hospital as early as 1891, and also at the same time in private practice. The method was taught to matriculates by actual demonstrations. Experiments were made of its effects in trachoma, hypertrophic nasal catarrh and ozena, gonorrhœa, keloid, and continued, in a great variety of diseases, and with a variety of metals at the positive pole. Obviously, the method once understood implies its application to a large number of cases and by any soluble metal. Papers and contributions to journals and societies have been published by my clinical assistants detailing my work and instruments and by Dr. Clarence C. Rice, of New York City.

Electrodes.—Successive applications to diverse morbid conditions continually suggested new electrodes suited to the individual classes of disease. These have been made as occasion arose by the Galvano-Faradic Manufacturing Company, of New York City, and may be bought of them.

Needles, Fig. 1. These are manufactured of any desired metal. I use, preferably, copper, zinc and iron at the positive pole and aluminium at the negative. About 1 millimeter in diameter and 8 centimeters in length form a convenient size. Insulated material restricts the action of the current to the locality desired to be affected and prevents action upon the sound skin. They fit an ordinary needle holder.

Bulbs.—Figs. 2 and 3. Like the needles these are manufactured of a variety of metals. For convenience they are constructed in sizes of the French catheter scale, each bulb capable of being attached by a screw thread to a universal handle. The sets resemble those known as Dr. Fry's, and were first made of copper by Dr. A. H. Goelet.

An important modification of the bulb (Fig. 4), devised by the writer more than a year ago, is to divide it longitudinally into one-half metal and the other half ebonite, thus affording a protected and an active side of the electrode for it often happens as in the rectum, urethral canal, cervical canal and other canals, sinuses or cavities, and in trachoma that it is undesirable at a single treatment to attack approximating surfaces; again, it may be desired to protect a given surface.

The handle curved at right angles is used in the post-nasal cavities. The metal may be bent to any desired angle; its tip is insulated and an insulating sheath exposes any desired area for active effect.



FIG. 5.—Writer's Protected Electrode and Handle.



FIG. 6.—“Soluble” Bulbs Attached to Handles.



FIG. 7.—Protected Sound of “Soluble” Metal, Copper, Zinc, Iron, etc.



FIG. 8.—Writer's Protected Nasal Electrode.

Obviously, electrodes for special cases will suggest them-

selves, and types familiar in form will be constructed of soluble metals as occasion demands.

Technique.—I have already expressed a preference based upon much experience, for low current strength and prolonged time. It is difficult to lay down rules which shall apply in so many diverse diseases. In needle puncture (copper or zinc needles) I prefer to use no more than 2 milliampères applied at any one site for about three to five minutes. In a case of sycosis, reported later on this was quite sufficient to cure the disease. In lupus, ulcerations, pustules and acne this is also quite enough current strength. Gautier reports using 50 milliampères in a case of lupus, but I have found the high current strength seriously objectionable because of the consequent electrolysis of tissue and extension of the time of healing. In hypertrophic nasal catarrh with copper bulbs, I find about 4 to 8 milliampères sufficient. In ozena the same; in trachoma 1 to 2 milliampères and in intra-uterine applications from 10 to 20 milliampères; in gonorrhea 1 to 2 milliampères.

No positive rule can be laid down, since much depends upon the size of the electrode. In order to facilitate accuracy of dosage, I employ copper bulbs graduated according to the French scale of catheter or other electrodes whose surface area is a known quantity.

The operator may convince himself, if he desires, of the great rapidity of the electric diffusion of the copper salt by sticking the needle lightly into his own skin, or that of a patient, and watching the almost immediate formation of a small circular area of an apple green color. This is also well seen in a small wart or similar growth; the mass turns light green. Or the copper needle may be inserted into the white of a "hard boiled egg" or into a piece of meat, and the same rapid formation and diffusion of the copper salt be noted.

A practical point of importance is to thoroughly polish each electrode immediately before using it. This is easily accomplished by the aid of a piece of fine emery paper.

The adherence of the electrode to the tissue is a peculiarity and a danger. Even with a current strength of from 2 to 4 milliampères this adherence is noticeable. Therefore even when low current strength is employed as during the

application of smooth metallic surfaces to mucous membrane as in nasal and throat diseases, in trachoma, urethritis, etc., the electrode should be kept in slow movement, either longitudinal or rotatory. In the case of needles plunged into tumors and of sounds within the uterus this adherence can not be overcome by any safe manipulation; the needle must be loosened by reversing the polarity and using from 4 to 8 milliampères for about five minutes. The adhesion is due to the formation of an albuminoid salt of copper (where the electrode is of copper).

An operative outfit consists of any good galvanic battery, a water rheostat, a sensitive galvanometer needle and appropriate electrodes.

Cases.—I present the records of a few illustrative cases. It is needless to say that much has been learned as to technique, precision and efficacy in securing results in individual diseases since my first cases were recorded. Certain cases of lupus, cancer, etc., now under treatment are reserved until sufficient time has elapsed to enable a mature opinion to be given as to results.

CHRONIC TINNITUS AURIUM.

Probably there are few minor troubles more annoying to the patient than a chronic ringing in the ears; certainly there is no minor condition more difficult of cure. The cases as I have seen them are often associated with some degree of catarrhal trouble and commonly with tympanic vertigo and moderate deafness.

Case 1.—H. E., age 33; cured. Referred to me March, 1893, by Prof. D. B. St. John Roosa, to relieve him, if possible, of a most annoying and persistent ringing in both ears. Five years ago had a "dry throat;" had little saliva; mucous membranes cracked and bled; was treated by sprays for two years with no benefit; then used antiseptic washes. The uvula was elongated and had been cut off. Throat never ceased to trouble him. Two years ago had the grip, and about this time the ringing began. Present condition: weary, "nervous," depressed and irritable with much frontal headache and an almost continual ringing, worse in the left ear. The sound is like that of a distant cricket or like a sharp

whistle; it worries him most when he is tired or when he lies down or after sexual intercourse. Sleep is often disturbed because he can not get rid of the sound in his ears. As a rule it is worse at night. Has likewise much post-nasal discharge. Hearing in left ear considerably impaired; has some vertigo. The first treatment to the ears and throat was by the static induced current, then the sinusoidal, both followed by amelioration in the degree of the sound and by intervals when it ceased for a few hours. But the progress was not satisfactory to me and I determined to treat the catarrhal condition first and cure it, before following up further applications to the aural region alone.

March 29. Electric diffusion, copper bulb, throughout the post-nasal and pharyngeal region, 12 milliampères five minutes to each side.

March 31. Discharges from nose anteriorly and posteriorly almost *nil*; ringing about the same.

April 3. Ringing unimproved; headache better; slight nasal discharge. Repeated treatment.

April 4. Raises slightly thick discharge from throat; watery discharge from nose; ringing same as ever.

April 5. No discharge. Treatment repeated. Reports never felt so well for years, of the catarrhal symptoms. Ringing in ears ceased during the treatment.

April 7. Headache; ringing in ears worse; no nasal discharge. Treatment five minutes, 10 milliampères.

April 8. For a half hour after rising this morning was free from the ringing.

April 10. Ringing ceases for long periods; no nasal discharge.

April 13. Ringing continuous. Treatment same.

April 14. Ringing very slight; no headache; very little nasal discharge. Treatment, five minutes, 5 milliampères.

April 15. Much ringing in left ear.

April 19. Reports a discharge from the left nostril which colored the pillow in the night; a good deal of catarrhal trouble; bright yellow discharge and intense headache, also that his hearing was not so good. Discontinued treatment at the patient's request.

May 3. Against the patient's desire I persevered with

electric diffusion, applying the electrode freely to his hypertrophied tonsils and post-nasal region on the sixth, tenth and thirteenth. The ringing still persisted in a marked degree.

May 19. Ringing the same; vertigo. Treatment same.

May 25. Ringing and catarrhal troubles have ceased since last treatment. The throat presented an almost normal appearance; the narrowing and congestion of the fauces had disappeared; the tonsils were normal in size. One more treatment was given and the patient was allowed to cease, as nothing further remained to be accomplished. The treatment by electric diffusion from copper had occupied about two months and had been repeated about twelve times.

Jan. 30, 1894. Patient reports that he has had no further ringing in ears and remains well of it, in spite of an attack of the "grip" during the winter.

TRACHOMA.

With the pathology and histology of this disease we have here nothing to do. It is merely a question of causing the absorption of the sago-like granulations or elevations in the conjunctiva, with the relief of the associate symptoms of pain, lacrymation and in the acute varieties the mucus discharge. The classical treatment is by operative or medicinal measures. The former removes the granulations by squeezing out their contents; the latter attempts to cause absorption by setting up by various drugs a certain grade of inflammatory reaction. It is here proposed to treat this obdurate affection by another method, viz., the combined action of electricity and a nascent metallic salt caused to permeate the affected tissue by means of the diffusive property of the electric current. This method is very successful.

The use of electric diffusion in this disease first occurred to me in the case of an Italian woman under treatment for goitre at my clinic. The case briefly follows:

Case 1.—Jan. 4, 1892, R. P., age 50; trachoma, both lids of both eyes. Extreme photophobia; intense corneal vascularity; excessive lacrymation; trachomatous bodies ("sago grains"); impaired vision. Treatment, electric diffusion from a copper electrode. An impromptu electrode was formed by bending a piece of copper wire into a suitable

U-shaped loop. The loop was then passed *slowly* over the affected surfaces of the lids, while at the same time a current of 2 milliampères was flowing. The reader is referred to later cases for more typical results, for the reason that the treatment was inadvertently substituted at times by the use of the negative pole. But the cornea cleared, the trachomatous bodies became greatly reduced in number, the photophobia was much less, no lacrymation; the vision improved; the patient could see better and was able to read. This case simply initiated a method which was afterward carried out with more care and greater detail in my clinic, by myself and my assistants.

Care in manipulation is requisite. The eyelid should be everted as is usual in applications of the sulphate of copper or alum pencils, or the special protected electrodes devised by myself (Fig. 4) may be employed, without everting the lids. The electrode should be kept very slowly in movement or it will adhere to the conjunctiva and cause slight laceration upon removal, or at least compel the operator to reverse the polarity. Any metal, soluble at either pole may be employed, but copper and zinc are undoubtedly the best. The electrode without current will cause pain and with current somewhat more pain. To annul the pain, cocaine may be used in the usual manner.

Case 2.—Acute trachoma, first stage. March 22, 1893, patient age 11, had purulent conjunctivitis; upper and lower lids of both eyes trachomatous. Treatment: Electric diffusion from copper electrode, 2 milliampères, one minute to each lid. After the first treatment the photophobia almost entirely ceased and the granules diminished in size. The patient received six applications and was cured. April 29, 1894, about a year later, reports that he had remained well.

Case 3.—July 21, 1893. P., age 21; trachoma second stage. Referred to the clinic by Dr. Francis Valk, of the Ophthalmological Department of the Post-Graduate Medical School. During one year had suffered severely from photophobia, lacrymation and pain. Extensive ulceration of cornea and lids highly trachomatous. Treatment: Electric diffusion from copper electrode, 3 milliampères. July 24, patient much better; no pain; swelling of lid and ptosis of right

eye much diminished. Less photophobia, soreness and lachrymation, trachomatous bodies very much softer and less gritty to contact of electrode. Electric diffusion from copper, 10 milliampères from two to three minutes. July 26, edema of the lids has entirely disappeared; slight ptosis remains; no lachrymation; trachomatous bodies no longer isolated; cornea almost entirely clear. Same treatment. July 31, after the fourth treatment the trachomatous bodies had become entirely absorbed. Cornea perfectly clear. Dr. Valk stated that the result "was 50 per cent. better than he could have secured with the classical methods of treatment." Six more similar treatments completed the patient's cure, with the simple exception that some slight conjunctival redness remained as well as a moderate sensitiveness to bright sunlight. May 8, 1894, as the patient has never returned he presumably has remained cured.

Case 4.—July 21, 1893, A. D., age 8; trachoma, second stage. Purulent conjunctivitis with congestion and edema of the surrounding tissues; both upper and lower lids profusely covered with trachomatous bodies. Five treatments, electric diffusion from copper electrode, 3 to 7 milliampères; cocaine. The first treatment was followed by diminution of the mucus discharge; of the pain, lacrymation and photophobia; the trachomatous bodies softened and were gradually absorbed. Cured.

Case 5.—August 30, 1893, W. T., age 16; granular lids for seven months; pain; stiffness of lids; photophobia; morning adherence of lids; electric diffusion from copper, 3 milliampères. After twelve treatments, case cured by October 30. Applications were imperfectly made, owing to the refractory nature of the patient.

Case 6.—Jan. 15, 1894, K. S., age 17; native of Egypt; trachoma, third stage; always had weak eyes; began to be troublesome five years ago. Has photophobia, lacrymation, constant muco-purulent discharge and pain. Can only see as "through smoke." Palpebral conjunctiva scarred and white. Both lower lids, palpebral conjunctiva, adherent and dragging in the eyeball. Cicatricial conjunctivitis. Case "incurable." Treatment: Electric diffusion from zinc electrode, 5 milliampères to conjunctivæ of both eyes.

March 9, 1894, reports both eyes better; now sees clearly; lacrymation has ceased; lids are no longer glued together in the morning by the mucus discharge. Repeated diffusion from zinc, 3 milliampères to lids of both eyes. March 23, 1894, adhesions between the conjunctiva and the eyeball at the left lower lid were treated with negative electrolysis, 1 milliampère. April 18, 1894, palpebral conjunctivæ have assumed a more normal appearance. Circulation improved; less induration; patient regards herself as very well.

Case 7.—March 23, 1894, M. B., age 11; acute trachoma, first stage. Lids edematous; conjunctivæ injected; lacrymation, upper and lower lids of both eyes trachomatous. Treatment: Electric diffusion from copper, 1 milliampère. March 26, no edema; conjunctivæ lessened; sago grains have disappeared; treatment same. March 28, 1894, much better; slight redness of conjunctivæ; no mucus discharge, pain or photophobia; eyes clear and bright, 3 milliampères to both eyes. April 13, 1894, cured.

HYPERTROPHIC RHINITIS AND PHARYNGITIS.

The class of cases here referred to were of a chronic type and exhibited anterior and posterior nasal discharge, generally thick and purulent; the disturbed sensation of swallowing, due to retained secretions in the post-nasal space, narrowing of the rhino-pharynx and the characteristic symptoms of hypertrophy of the nasal and pharyngeal mucous membrane. Their treatment was carried out by electrodes of copper and zinc devised by the writer, see Figs. 3, 4 and 6, and by a method devised and taught by him to clinical assistants, among others to Dr. M. A. Cleaves, who has written a paper whose originality is derived substantially from the writer's teaching in this as in other branches of metallic electrolysis. Struck by the results obtainable in this disease by this method, I also called the attention of Dr. Clarence C. Rice of the Department of Laryngology, Post-Graduate Medical School, to these results and he has, he writes, made trial of the soluble metallic electrodes in a number of cases which he has reported at a meeting of the American Laryngological Association in Washington.

Case 1.—Nov. 27, 1891, B. M., age 15. *Ozena.* One year ago patient contracted an acute catarrhal cold; it continued

a month; since then has had a chronic catarrhal condition of the nasal passages. Odor began four months ago. There is a greenish muco-purulent discharge from the nose, post-nasal droppings and a slight irritative cough. Treatment; Electric diffusion from copper electrode. As in the first trial of this method in trachoma, so in this case the negative pole was also used. But experience soon taught me to confine the treatment to electric diffusion from the positive metallic electrode. By December 9, after four treatments the discharge was less, the odor less noticeable and the respiration freer.

January 8, examined by Dr. C. C. Rice who reports deviation of septum toward right; left nostril twice the width of the right; middle turbinated bones covered with dry scaly secretions; pharynx dry with hypertrophied ridges on the sides. Further treatment by diffusion from copper was carried on, 1 milliampère for ten minutes. January 15 and 18, 5 milliampères each nostril, also same January 20, 22 and 27. Discharge diminished and less greenish. February 1, 3 and 5 same treatment. Patient though not cured is much better; less discharge, odor and headache. Improved.

With the present improvement in methods and electrodes I should expect to cure this patient should the opportunity present itself.

Case 2.—August 8, 1893, D. L. G., age 41, ozena; post-nasal catarrh, atrophic. Has always "taken cold" easily. Had catarrh at 13 years of age; at 18 it had increased a great deal and he began to use salt water and a great many other nasal douches and "went to a great many doctors." His sense of smell became much impaired nine years ago and has been growing worse ever since, until at present he can not detect odors. The patient states, though I have had no opportunity of verifying his statement, that one year ago he had the antrum opened by Dr. Toeplitz, assistant to Dr. Knapp, and pus evacuated. This opening is still patent and must be plugged twice daily. Symptoms: Copious and most offensive anterior and post-nasal discharge; a great many crusts form; the nose bleeds easily; odor from patient's nose and mouth most offensive. Treatment: Electric diffusion from copper bulbs, Nos. 27 and 29 (Fig. 3) to

naso-pharynx, 15 to 25 milliampères, occupying about five minutes. August 11, same treatment. Pharynx very much less congested; more discharge; patient says he feels very much better. August 15 and 23, crusts free themselves more easily; increased discharge from nose and slight bleeding after douching; treatment same. August 30, patient reports that his condition is very greatly improved; the incrustations remarkably diminished; very much less discharge, and that morning for the first time in eight years the sense of smell had returned to him and he had smelled paint and once more enjoyed eating; there was no offensive odor. The patient expressed himself as "50 per cent. better," and stated that no other treatment had ever accomplished as much for him.

Case 3.—Oct. 21, 1892, A. R., age 9, profuse muco-purulent discharge from the nose; nasal and pharyngeal obstruction of one year's duration. Treatment: Electric diffusion from copper electrode, about five minutes in duration and with a current strength varying from 5 to 10 milliampères. Symptoms began to improve at once and after fourteen treatments, each several days apart, the patient was cured.

Case 4.—April 5, 1893, F. A., age 20; hypertrophic rhinitis. Had diphtheria in November, 1891. Ever since has had severe catarrhal trouble in frontal sinuses and nasal passages, anterior and posterior. Profuse, thick, yellowish discharge and much dropping of the discharge posteriorly. Feeling of intense fullness across forehead; upper lip and anterior portions of nose reddened and excoriated. Treatment: Electric diffusion from copper electrodes in anterior and posterior nasal passages on the left side. April 12, discharge not nearly so profuse nor as yellow on the side treated; less redness about the nose and lip. Right side treated in same manner as left; 10 milliampères for five minutes. Like many patients of this class he did not return and the case merely suffices to point out the immediately favorable effect of the first treatment.

Case 5.—Mrs. G. W. E., age 34, nasal catarrh, hypertrophic.

NOTE.—Unfortunately, owing to unavoidable circumstances, this patient ceased treatment and has not since been heard from. It is to be regretted that the same treatment, as might easily be done, should not have been tried for the antrum.

Has had catarrh for three years with constant "dropping in back of throat," heaviness and dullness in head around eyes; used handkerchief constantly; good deal of nausea.

April 28. Electrolytic diffusion to left nostril. Positive pole, 3 milliampères for fifteen minutes.

May 3. Feeling of heaviness in head in morning gone; no nausea; application made to left nostril 5 milliampères, ten minutes; nose feels very much clearer; discomfort from application gone in half an hour.

May 5. Same treatment to both nostrils; is feeling a good deal better; dropping in back of throat gone; scabbing in interior nostril does not occur, also diminution in amount of discharge.

May 9. Until yesterday felt well; has taken cold and amount of discharge has greatly increased; large scab in left nostril; this was treated locally.

May 15. Very much less discharge; 6 milliampères to each nostril.

June 24. About twelve treatments more of same strength; application also made to pharynx and naso-pharynx, about 10 milliampères. Is very much better and is troubled but little. Went away on vacation at this time and the last of September returned feeling well and nasal symptoms entirely relieved. Cured.

Case 6.—Miss H. J., age 48; post-nasal catarrh. About fifteen years ago affection began in left side; had ringing in ears and heavy cold; since has had constant buzzing on that side; ticking of watch not heard; right ear normal. Is not particularly susceptible to colds; hearing is worse with a "cold"; no pain; has dropping of secretions into throat. Appearances, left side, pharynx atrophic; right side, pharynx hypertrophic; soft palate and entire isthmus dusky red. Treatment: Electrolytic diffusion 10 milliampères, applied positive pole about six minutes all over pharynx, also through left nares 10 milliampères five minutes. For a few minutes the amount used was 20 milliampères. Cured.

FOLLICULAR TONSILLITIS.

Case 1.—Oct. 18, 1893, B. G. A., age 15, throat began to be sore two days previously; painful and swollen; sense of

malaise and nausea; tonsils enlarged and grayish-white spots on both. Treatment: Electric diffusion from copper electrode to every spot.

October 20. No more trouble with throat. Tonsils normal in appearance except for slight increase in their normal redness.

Case 2.—Jan. 18, 1894, F. D., age 18; shivering and hot flushes, malaise; temperature 100; grayish-white spots on tonsil. Treatment: Electric diffusion from copper, 10 milliampères to every follicle as well as over entire tonsil. January 17. Patient reports that the throat was entirely relieved the next morning and to-day feels entirely well. Tonsils about normal in appearance.

URETHRITIS.

Case 1.—May 4, 1892, A. M., age 30; contracted disease in December, 1891. For ten months thought himself well. Discharge recommenced May 1, 1892; slight, free and painless; no treatment.

May 1. Treatment: Intra-urethral (from neck of bladder to entire mucous surface), 2 to 3 milliampères electric.

May 11. Electric diffusion from copper electrode, 2 to 3 milliampères. A brass bulb of proper size and connected to an insulated stem was passed as far as the neck of the bladder, the current turned on and the electrode then slowly withdrawn, thus bringing under the influence of the cupric and zinc diffusion the entire urethral surface. The dispersing electrode was placed upon the abdomen.

May 13. Patient reports that the discharge has entirely ceased. Later on he reported that it never returned and he remained cured.

Case 2.—A. M., March 19, 1893. One year later the patient referred to in Case 1, exposed himself to a new infection and contracted a severe attack of urethritis. Mindful of his previous cure he returned for the same treatment. The discharge was profuse, whitish and of the usual consistency; there was pain upon micturition. Treatment: Electric diffusion from copper, 4 milliampères, the electrode slowly withdrawn. At one moment when the electrode temporarily adhered or "stuck," the current was reversed to negative to loosen it.

March 27. Reports that he is much better.

March 29. Reports to-day complete cessation of the discharge after the treatment of the 19th, but that he has now a slight relapse from "drinking too much." Treatment renewed.

March 31. Reports that he is cured.

It may be noted here that extreme care to prevent adhesion of the electrode to the mucous membrane must be exercised in these cases. A delicate milliampèremeter is imperatively necessary, as well as a good rheostat. From 2 to 3 milliampères of current is sufficient and the electrode must be kept in motion. At least this is the method of treating the urethra which has forced itself on my attention as essential. It is beyond question the great feature of this method, in contra-distinction to that by injections, that the mucous membrane is electrically permeated with any given metallic salt, say the chlorid of zinc or copper, rather than simply superficially washed by a solution of the same salt. There is an actual chemic union of the metallic salt and the deeper albuminous constituents of the tissue.

TUMORS, ETC.

Case 1.—May 18, 1892, E. S., age 60; vascular tumor on upper lip, nine years' standing, increasing in size. Three-fourths of an inch in diameter, bluish cast of color and can be partially emptied by pressure. Treatment: Electro-cocain, local anesthesia; first punctured by a platinum needle, positive hole, 15 milliampères for ten minutes. Upon withdrawing the needle, considerable hemorrhage ensued. It therefore occurred to me to insert an iron needle, positive pole, and secure the electric diffusion of the oxychlorid of iron—a styptic salt. This was done with 15 milliampères for five minutes. There was no hemorrhage upon the withdrawal of the needle and the tumor shrunk visibly in size.

May 20. Tumor more compact; electric diffusion from an electrode 25 milliampères, twenty minutes. To withdraw the electrode without tearing tissue, the current was reversed at 15 milliampères for five minutes; no hemorrhage; needle almost destroyed by the action of the current. Tumor contracted.

May 23. Tumor reduced one-third in size. This patient did not return.

Case 2.—Feb. 13, 1894, Mrs. R., age 30; lipoma, one and one-half inches long by one inch wide at base of neck. Patient was unwilling to take ether to have the growth removed and did not want to have a scar. Experimentally, since I knew of no previous fatty tumor removed by electricity, I consented to try and extirpate it. Operation: Electro-cocain, local anesthesia, 7 milliampères, 10 per cent. solution cocain for ten minutes. A puncture was made with a microscopic trocar and the small piece of tissue sent to Dr. H. T. Brooke of the Post-Graduate School, Pathologic Laboratory, for examination. He subsequently pronounced it to be a lipoma. A copper electrode, three-quarters of an inch in length and one-sixteenth in diameter was inserted into the puncture made by the trocar, the skin being protected by the insulation of the stem of the electrode. The electrode thus sunk into the center of the mass of the tumor was allowed to remain for twenty-three minutes, with a current strength ranging from 10 to 25 milliampères. The resistance to the current flow was great, owing to the fatty nature of the growth. At 25 milliampères the patient had violent palpitation of the heart and was upon the verge of syncope, owing to the presence of the electrode near the great nerve trunks. The wound being antiseptic no special dressing was applied.

February 28. Patient reports that the tumor has entirely disappeared.

May 12. Patient returned to New York from Chicago and presents herself for examination. No trace of the growth remains; a slight red spot rapidly disappearing marks the site of the puncture. Cured.

Case 3.—May 16, 1893. M. H. H., age 25; wen or dermoid cyst. Tumor began six years ago, about the size of a pea on the neck below and behind the ear. Two years ago it began to increase in size and to-day is about one inch and one-quarter in diameter. The patient decisively refuses to take an anesthesia, wishes to avoid the scar from an incision and asks to have the tumor removed by the aid of electricity. Tumor hard and movable. Treatment: Electro-cocain, local anesthesia to skin over tumor; puncture made, contents of

sac mostly expressed and cavity injected with a saturated solution of iodid of potash—a non-soluble metallic electrode remaining within the sac with the solution; a current of 15 milliampères was allowed to flow for ten minutes, with the purpose of setting free the iodin and obtaining its effect in a nascent state upon the lining of the sac.

May 19. No soreness. Tumor soft and pliable but hardening.

May 22. Tumor about two-thirds of its former size.

May 23. Tumor again filled and the operation was a most obvious failure. I resolved to try another method, viz., electric diffusion from a soluble metal. This was done with 20 to 30 milliampères of current for about ten minutes.

May 31. Slight serious discharge of an orange yellow color.

July 1. Patient not seen again until this date, when he returned to state that the discharge had quickly ceased and that the tumor had entirely disappeared, leaving no evidence of the operation. Seen May 1, nearly one year later, there has been no recurrence. Cured.

SYCOSIS PARASITICA.

E. H., age 50. Disease began seven years ago. Patient stated that he had tried to pull out an ingrowing hair and it broke off. A papule formed here, and following this a diffuse redness began to spread itself in all directions from the site (the left side of the face just in front of the ear); at the same time papules formed, coalesced and spread outward. No pus was formed at first but after a short time the tips of pimples became white and pus was discharged. This was followed by an exudation of serum from the excoriated surface and shortly before it was operated upon discharged in twenty-four hours one ounce of serum. He has been everywhere and tried every treatment to no advantage until last October, the 21st, when he was operated upon at the New York Post-Graduate Hospital by Dr. R. Y. Morris who removed the skin and subjacent tissue over an area in front of the ear about five and one-half inches long and two inches wide. Skin grafts were then applied which did well till one day about a week later he was out in the cold and a portion of the ears froze and had to be removed, which left when healed a scar two inches long and one inch wide in the center of the wound. All went well and the part looked healthy

till February last, when signs of the old trouble began to show themselves in the skin just outside of line of incision, and when he presented himself to me the characteristic papules had spread themselves over a surface of about three inches long by two wide; in places the tissue was covered with small blebs and had a boggy appearance, into which a needle could be thrust for a distance of one-quarter of an inch without producing pain or discomfort.

April 20, he began treatment, which consisted of electric diffusion from copper electrodes $1\frac{1}{2}$ to 2 milliampères ten to twenty applications, lasting in all ten to fifteen minutes, until the green oxychlorid of copper gave a distinct coloration to skin and tissue, using the positive pole, with the negative in back of neck. This was repeated eight times, the last one about May 10. The aluminium needle was used twice and the negative pole with equally successful results.

May 14. He came with the skin over lesion showing a normal and healthy condition. Treatment ceased with the injunction to return if there is the slightest evidence of recurrence.

NOTE—The alternatives in this case were, I am informed by Dr. Morris, further incision or curetting, both of which were objectionable, because the cicatrix was already extremely tense and no further tissue could well be sacrificed. The effect of the electric diffusion method was remarkable. It left behind it almost no observable cicatricial tension, in this respect much unlike ordinary electrolysis, and unlike the effects from the knife or the curette.

I have employed electric diffusion from metals in a variety of cases not here enumerated. Its action upon hemorrhoids has been to cure them in the few cases in which I have tried it. I have used it in endometritis, cystic degeneration of the cervix uteri, in ulcerations of the rectum, in keloid growths, etc. I am present treating lupus and epithelioma with thus far favorable results, and have even begun upon a case of sarcoma, but it is too early to make any report upon this later set of cases. Dr. Gautier has reported excellent results in a great variety of gynecologic procedures and conditions.

CONCLUSIONS.

1. The salts of many metals may be electrically dissolved from metallic electrodes, and at the same time be caused to

permeate human tissue to a considerable depth. In the case of copper, upon dead tissue, with a current strength equal to that employed in living tissue, this depth is visible as an apple green color, in a radius about the electrode of from one-fourth to one-half of an inch; it probably extends invisibly much further, shading off to a minimum.

2. The electrically formed and electrically diffused metallic salts are not destructive to tissue in the sense that ordinary electrolysis is; the effect is rather by the presence of a partially insoluble salt and by the effect of a newly formed organo-metallic salt, de-nutritive or absorbing upon diseased tissues.

3. It would seem to the writer that these electrically formed salts, in forming new albumin composed of the metal used as an electrode possess a selective affinity for diseased in preference to healthy tissue, or at least produce a more profound reaction upon the morbid tissue, causing a favorable alteration in the nutrition of the part.

4. Electric diffusion is greatly superior to topical applications, for the reason that the medicament is caused to penetrate the tissue acted upon.

5. This method opens up a new and interesting branch of electro-therapy.

